MINUTES OF THE NASA ENVIRONMENTAL COMPATIBILITY RESEARCH WORKSHOP
Held May 19-21, 1998

At the Embassy Suites Hotel, Cleveland, Ohio

The following persons attended this Workshop.

First	Last Name	Company
Krish	Ahuja	Georgia Institute of Technology
Richard	Antcliff	NASA Langley
Thomas	Auxier	Pratt & Whitney
Howard	Aylesworth	Aerospace Industries Association Of America
Peter	Batterton	NASA Lewis
Kevin	Black	United Airlines
David	Bowles	NASA Langley
Steve	Bradford	FAA
Gerald	Brines	Allison Engine Company
Lawrence	Butler	GE Aircraft Engines
Carol	Cash	GE Aircraft Engines
Adina	Cherry	SAIC
Kestutis	Civinskas	NASA Lewis
John-Paul	Clarke	Massachusetts Institute of Technology
Thomas	Connor	FAA
Vic	Corsiglia	NASA Ames
Art	Coulomb	ATA
Charles	Cowan	Cutler & Stanfield
Robert	Cuthbertson	The Boeing Company
William	Dalton	Allison Engine Company
Ruben	DelRosario	NASA Lewis
Barbara	Dillon	SAIC
Willard	Dodds	GE Aircraft Engines
John	Dodge	Allied Signal
Sam	Dollyhigh	NASA Langley
Michael	Dudley	NASA Ames
Douglas	Dwoyer	NASA Langley
David	Fancher	GE Aircraft Engines
Rick	Fucik	Northrop Grumman Commercial Aircraft Division
Sue	Gander	Center for Clean Air Policy
Glen	Gilyard	NASA Dryden
Phillip	Gliebe	GE Aircraft Engines
John	Goulding	BFGoodrich Aerospace
John	Graham	Los Angeles International Airport
Mark	Guynn	NASA Langley
Richard	Halik	Port Authority NY/NJ
William	Haller	NASA Lewis
Peter	Hart	Allison Engine Company

Thomas	Hartmann	Lockheed Martin
Tim	Haskell	Nashville International Airport
Robert	Howard	Sverdrup/AEDC
Dennis	Huff	NASA Lewis
Lynae	Jacobson	SEATAC Airport
Rod	Jago	SAIC
Betty Ann	Kane	National Organization to Insure Sound
Barry	Kiel	AFRL/PRTC
Herb	Kuntz	Lockheed Martin
Richard	Lawrence	NASA Goddard
Chi-Ming	Lee	NASA Lewis
Diana	Liang	FAA
Anita	Liang	NASA Lewis
Dick	Linn	Dallas-Ft. Worth Airport
James	Littleton	FAA
Gary	Machles	GE Aircraft Engines
Max	Malone	United Airlines
Bryan	Manning	EPA
Ty	Marien	NASA Langley
William	Marx	FAA
Doug	Mathews	Pratt & Whitney
Peter	McCallum	NASA Lewis
Richard	Miake-Lye	Aerodyne Research Inc.
Nicholas	Miller	HMMH
John	Mitchem	Allied Signal
Stephen	Morford	Pratt & Whitney
Frank	Murray	SAIC Consultant
Cindy	Newberg	EPA
Richard	Niedzwiecki	NASA Lewis
Charlie	Parente	Northrop Grumman
Eugene	Peters	Landrum & Brown
Steven	Pflaum	McDermott, Will, & Emery
Clemans	Powell	NASA Langley
Carol	Quinn	NASA Lewis
Ronald	Ray	NASA Dryden
Lisa	Reuss	SAIC
Karen	Robertson	Dallas-Ft. Worth Airport
John	Rohde	NASA Lewis
Carol	Russo	NASA Lewis
Dennis	Sawyer	TRW
David	Schein	Northrop Grumman
Stephen	Seidel	White House
Paul	Senick	NASA Lewis
Ben	Sharp	Wyle Laboratories
Belur	Shivashankara	The Boeing Company

Rickey	Shyne	NASA Lewis
George	Siple	Camp Dresser & McKee Inc
Glenn	Smith	NASA HQ
Chuck	Smith	NASA Ames
Brian	Smith	NASA Ames
Christoph	Snyder	NASA Lewis
Paul	Soderman	NASA Ames
David	Stephens	NASA Langley
Paul	Stolpman	EPA
Gary	Stowell	San Jose International Airport
Donald	Sutkus	The Boeing Company
Bob	Tacina	NASA Lewis
Len	Tobias	NASA Ames
Ian	Waitz	Massachusetts Institute of Technology
Donald	Weir	Allied Signal
Gregory	Wellman	Landrum & Brown
Howard	Wesoky	NASA HQ
Chowen	Wey	NASA Lewis
Timothy	Wickenheiser	NASA Lewis
William	Willshire	NASA Langley
Jia	Yu	BFGoodrich Aerospace
Isam	Yunis	NASA Lewis

The following represents a synopsis of the discussion at this Workshop as related to the published agenda.

Welcome and Introductions
Comments on Workshop I

Mr. Howard Wesoky opened the Workshop by welcoming attendees and thanking them for their participation. He then reviewed where the group was in the workshop process. He mentioned that NASA management had asked the Environmental Compatibility Assessment Core Team to assess the ability of current NASA research and technology programs to achieve the three pillar noise and emissions goals. This assessment began in Workshop 1 and would continue at this workshop. He then reviewed some of the specific recommendations and issues from the Atlanta Workshop and the goals for this workshop. Mr. Wesoky's entire remarks are included as Attachment A-1. Mr. Wesoky turned the meeting over to the chairman, Mr. Frank Murray.

Housekeeping and Administration
Website Information
Agenda for Workshop II

Mr. Murray reiterated Mr. Wesoky's welcome to attendees and briefly covered meeting administration matters. He requested that all attendees fill out meeting registration forms identifying which group, "Emissions" or "Noise", they would be attending. He also requested that those planning on attending a tour of the Lewis facility indicate their intent on the form.

Ms. Adina Cherry, SAIC's overall meeting coordinator, provided an updated status of NASA's website that identifies what information is available on the web, and indicated future plans for additional items.

Mr. Murray then reviewed the Agenda, giving a brief description of each item and how it fit into the overall purposes and goal scheme of the second Workshop. He also asked that any comments on the summary of the first Workshop (distributed with the Agenda of this meeting) be provided to him and said a revised summary would be included in the minutes of the second Workshop. Mr. Murray's entire opening remarks are included as Attachment A-2. (Revised Summary Report for Workshop 1 can be found in Attachment A-4).

EPA Study of Airport Local Air Quality

Mr. Bryan Manning presented a briefing on regional ground level emissions from commercial aircraft. He stated that many U.S. cities face significant air quality problems and that commercial aircraft are under increasing scrutiny since they are expected to comprise a growing proportion of regional emissions. He also stated that aircraft ground level emissions are one of the four most important environmental issues connected to airports. Since aviation is the fastest growing mode of travel in the country with 32 of the nation's 50 busiest airports expanding and new runways planned at 60 of the 100 largest airports, the emission problem if not countered, will exceed acceptable standards. Mr. Manning also presented material on the health and environmental effects of air pollutants. Data was also provided on several non-attainment areas in the U.S. with preliminary results presented for five different air pollutants. Mr. Manning summarized his presentation with four major points: 1) State and local air quality organizations have a critical need for significant NOx and particulate matter reductions from any and all source, 2) commercial aircraft's contribution to ground-level emissions is a regional air quality issue and should receive specific consideration, 3) growth in commercial aircraft is occurring when other emission sources are drastically reducing emissions, thereby accentuating the growth in aircraft emissions, and 4) commercial aircraft is a small but significant source of regional ground-level emissions. Mr. Manning's briefing is available on our website under the heading "Local Air Quality Presentation, Manning/EPA".

Comments and Discussion

Ms. Sue Gander and Mr. Steve Morford provided some brief comments on Mr. Manning's presentation at this point. Some of these comments were: 1) Revised operational procedures at airports become more important as air traffic grows: How is the international community addressing this issue? The response was that they are handling it on an airport basis whereas we are handling it on a regional basis. 2) Who provided the forecast data? The response identified the FAA as the provider. 3) Have economic factors been considered in the analysis? The response was "only superficially." 4) A final comment was that the FAA is now looking at other emitters in the airport environment e.g., power units, ground support equipment, etc.

Communications, Navigation, Surveillance/Air Traffic Management (CNS/ATM) Enhancements to Reduce Aircraft Emissions

Ms. Diana Liang presented the following briefing, stating that the study objectives include the following:

- Develop preliminary estimates of fuel savings and resulting emission reductions resulting from CNS/ATM enhancements in the US.

- Results should identify the upper bound of savings that could be achieved in the best case situation.

Ms. Liang stated that the period of evaluation is 1996-2015 and covers CNS/ATM improvements in U.S. controlled oceanic airspace, CONUS en route and terminal airspace, and U.S. surface operations. Baseline and future national airspace scenarios were reviewed as well as the modeling scenarios used in the analysis. Ms. Liang also presented the assumptions, sources of data, fleet mix, results, and metrics of the study. Ms. Liang presented annual fuel savings by 2015 and subsequent reductions in NOx, CO, and hydrocarbons. Finally, the remaining schedule of this FAA activity was reviewed and other follow-on activities were described. The entire briefing, titled "CNS/ATM Enhancements to Reduce Aircraft Emissions", is available on the website.

Comments and Discussion

Mr. Howard Aylesworth and Ms. Cindy Newburg provided comments on the CNS/ATM presentation. Some of these comments follow: 1) Will variable growth rates be used in follow-on activities? The response indicated that this would be considered. 2) It was also mentioned that moving the CNS/ATM modernization effort forward would provide earlier favorable impacts. 3) Unimpeded aircraft taxiing procedures were mentioned as a significant reducer of local airport emissions, particularly NOx. 4) The point was made that most of the CNS/ATM benefits accrued above 3000 ft., which was identified as the cruise altitude in the study.

Where do we go from Kyoto? Aviation and Global Climate Change

Mr. Paul Stolpman presented a briefing on the White House and aviation sector activities related to Kyoto. The following is a synopsis of his presentation:

He related that industrialized countries of the world have agreed to cut emissions by 5.5% below 1990 levels by 2008-2012. Six different gases/emissions were covered and trading would be allowed for domestic and international compliance. Since Kyoto, President Clinton has submitted a $6.3 billion budget request for technology research and tax incentives. Ongoing economic and policy analyses are addressing costs associated with reaching the targets, the role of technology, and domestic and international emissions trading options. He went on to say that aviation emissions are becoming increasingly important from a number of environmental perspectives – urban ozone, stratospheric ozone depletion, and climate change. Whereas other sources are being or beginning to be controlled, aviation emissions continue to grow. In regard to the trading program, the Kyoto Protocol authorizes international greenhouse gas emissions trading for countries that made commitments. The U.S. plans to implement a domestic trading program for the 2008-2012 budget period. "Rules of the game" still need to be developed and the U.S. will pursue meaningful participation on part of key developing countries. Mr. Stolpman stated that the President made this latter issue a condition of his submitting the Kyoto Protocol to the Senate for ratification. A key point made during this briefing was that the trading program will be a domestic as well as an international program.

Global Climate Change: A White House Perspective:

Mr. Steve Seidel followed Mr. Stolpman and stated that he was extremely pleased with what was being accomplished in these Workshops and thanked those present for their interest and support of this program. He stated that developing countries will increase their contributions to the emission problem and increasing attention will need to paid to that fact. Resolution of this problem will continue to evolve. The ICAO Committee on Aviation Environmental Protection (CAEP) work program will analyze options for technology assessments, cruise based certification, best operating practices, and an accelerated CNS/ATM implementation program. Additionally, an evaluation of market based options will be addressed. Mr. Seidel stated that CNS/ATM is significant in reducing fuel consumption but is not the only answer when it comes to reducing emissions. In regard to trading credits, no commitments will be made until 2008-2012 so trading won't take place until then. The

method or system for trading still has to be developed. No credits will be given until 2008. Mr. Seidel again thanked NASA and Workshop participants for their support of this effort.

Noise:

Certification and Future ICAO Work Program

Mr. Thomas Connor presented a briefing on aircraft noise control and the role of Federal research. In this briefing, he reviewed the regulatory documents pertaining to both national and international noise. He also reviewed the structure of the ICAO CAEP and the working groups supporting CAEP. He discussed the utilization of DNL for measuring noise in the airport environment and the breakouts of moderate, significant, and severe exposures as they relate to DNL decibel levels. He stated that the FAA's environmental R&D mission is to provide strong leadership in mitigating aviation's adverse impact on the public consistent with an effective aviation system. In describing FAA's environmental roadmap, he compared the program to a "three legged stool" with source reduction, abatement procedures, and land use planning providing the legs of the stool. The ultimate goal of the program is to provide a safe, efficient aviation system and protection of public health and welfare. Mr. Connor's presentation is on the Website and is identified as "Aircraft Noise Control and the Role of Federal Research".

Worldwide Impacts

Mr. Ben Sharp presented a briefing of a study conducted to forecast noise impact for 130 airports worldwide. The methodology utilized for this study relied on data from all scheduled world jet and turboprop passenger, cargo, and charter operations based on local criteria and metrics. Population impact was based on a world-wide population database, and generalized relationships for impact area vs. aircraft operations were developed based on the actual data received from airports in order to calculate impacted area at airports for which data is unavailable. Mr. Sharp stressed that this methodology provides an estimate of the current and future aggregate world noise impact, and does *not* attempt to predict the actual noise impact at specific airports. Mr. Sharp's presentation can be reviewed on the website under the title "World Airport Noise Impact Forecasts".

Comments and Discussion

Mr. Dick Linn and Ms. Betty Ann Kane provided comments on these presentations and the airport noise problem in general. The following represents a synopsis of the comments made under this agenda item. It was brought out under this comment session that the 65 DNL selection was made primarily because of economics. It was also mentioned that the NASA Advanced Subsonic Transport (AST) program is the prime contributor to noise reduction and that the current budget in AST does not allow for extensive testing. Furthermore, NASA will lose its extensive noise experience if this situation prevails. It was also stated that in order to achieve a 10-dB reduction "tweaking" would not suffice. Major changes in technology and operations will be required. FAA and NASA need more money if the goals are to be met in the timeframe specified. Dick Linn stated that increased fuel prices would force the issue for additional and timely research. Finally, Dick Linn provided copies of a paper he developed in response to several participants at the last Workshop. This paper, "Ramblings of an Old Aviation Enthusiast" is available on the Web.

Coordination with FAA "Environmental Research Beyond 2000"

Mr. Jim Littleton's presentation related that the goals of the FAA are to: 1) Remove/mitigate environmental impediments to aviation growth, 2) to achieve this goal with participation from all interested parties, and 3) identify R&D strategies that can resolve environmental impediments and fulfill FAA's environmental mission. Overall environmental strategies include: designing cost

effective solutions; providing stakeholders a voice; serving as an advocate for both the environment and aviation growth; and promoting compatibility between environmental concerns and other areas of FAA research and policymaking. Since resources are limited--only two percent of the FAA's R&D budget--best use of these limited resources must be made. The research of the FAA and NASA compliment each other in that NASA does the basic research, proof of concept and technology feasibility, while the FAA regulates, provides policy and guidance, and attempts to balance the needs of all stakeholders. The ultimate goal then for the FAA is to provide a focused, cost effective environmental R&D program for 2000 and beyond. A final remark made during this presentation was that the FAA is more involved with near-term issues while NASA is more concerned with future issues. This briefing in its entirety is contained on the Website under the title "Environmental Research beyond 2000" FAA/EEA.

Scenarios for Aviation's Growth: Opportunities for Advanced Technology

Airport Noise Study for Future Fleet Scenarios

The objective of this study was to examine the effect of inserting new technology aircraft that meet the Pillar One Noise Goal into the fleet at several airports, while at the same time allowing annual airport operations to increase. The purpose is to put bounds on the airport noise exposure problem.

Mr. Ty Marien began by describing the two scenarios that would be used for comparison purposes. For each of these he provided the key assumptions regarding the composition of the fleet of jet aircraft. The first called for no new technology improvement beyond 1997 out to the year 2050, however stage 2 aircraft would be removed by the year 2000. For the Technology Improvement Insertion Scenario stage 2 aircraft would be removed by 2000, then starting in the year 2007 all new aircraft entering the fleet would be 10dB quieter than the present technology, finally by 2017 all new aircraft entering the fleet would be 20dB quieter.

In order to evaluate these scenarios, it was necessary to model the technology mix in the fleet as well as aircraft operations at an airport for a given year. Based on these inputs, the study looked at the results of two airports with different traffic profiles (mixes) of short haul, long haul and propeller aircraft and differing expectations as to the growth in each of these classes. The two airports studied were Washington Dulles International and Pittsburgh International.

The summary of the study showed the following: First, without additional noise reduction technologies, noise levels increase over time once the removal of Stage 2 aircraft has been completed due to the increased traffic projected at each of the airports. Second, noise reduction technologies, that meet the Three Pillar Noise Goal, have the potential to decrease the noise levels around the airports despite the increase in aircraft operations. Third, the benefits of additional noise reduction technologies will be limited at some airports unless quieter turboprop aircraft are introduced or replaced by quiet jets.

The detailed charts for Mr. Marien's presentation can be found on the website as "Airport Noise Study for Future Fleet Scenarios". Future study plans call for an extension of this study to more airports and adding differing scenarios. In addition further study will be undertaken to include rotorcraft operations.

Impact of Technology on Future Emissions

Mr. Mark Guynn presented a briefing of a study that assessed the potential impact of technology advances on future emissions. At the beginning of the presentation Mr. Guynn identified several important caveats regarding the assumptions used in the study. First, NASA technologies used to project the future are at various levels of maturity and that after additional research some may be

deemed impractical or less beneficial than anticipated. Second, the costs associated with both development and implementation have not been examined and these costs could be critical to the use of the technologies. Third, for these technologies to be viable they must be compatible with the other requirements of the Three Pillar Goals.

The key parameter measured in this study is the consumption of fuel. This is estimated based on future projections of the type of aircraft in the fleet, and the growth in the volume of air travel and the travel patterns. Projected growth in air traffic varies from 2-% to 4-% annually during the period 1995-2050. A mid-range scenario, resulting in an average annual growth rate of 3.1-% was selected for the emissions projections in the study. The varying assumptions yielded fuel consumption increases by 2050 of between 150% and 190% relative to today's levels. The differences reflect the variety of projections regarding the types of aircraft in the fleet and technologies in use. Concurrently NOx emissions are projected to increase 30% to 250% by 2050 relative to today.

As part of the presentation several world maps were presented showing the traffic patterns and the amount of fuel burned in various parts of the globe. It is interesting to note that more than 70% of the fuel consumption currently takes place between 30 degrees-north and 60 degrees-north latitude. This includes most of the United States and Western Europe as well as Japan.

The summary provided four principal conclusions: First, projected advances in technology are not sufficient to counteract the growth in traffic. Second, impacts of technology advances on future total emissions are a function of the opportunity for introducing new aircraft into the fleet. Third, the projected benefits of NASA technology programs indicate the potential for 0-13-% reduction in fuel burn and 30-60-% reduction in NO_x emissions relative to ICAO projections for 2050. Finally, NASA technologies to be viable must be compatible with other NASA Pillar goals, including affordability of air travel.

The briefing materials for Mr. Guynn's presentation are identified on the website as "Potential Impact of Aircraft Technology Advances on Future CO_2 and NO_x Emissions".

Zero Emissions Aircraft

Mr. Chris Snyder presented a comparison of alternative systems (referred to as "zero emission aircraft") against a conventional baseline. This study was an extension of the preliminary work done by Dr. Ian Waitz and Dr. Pannathur of MIT. Dr. Waitz presented the results of the MIT study at Workshop I in Atlanta. At that time Dr. Waitz acknowledged that his study needed greater depth and analysis before any significant conclusions about potential zero emissions aircraft could be drawn. Mr. Snyder's study, while far from comprehensive, provided that second look.

In his presentation, Mr. Snyder described the key parameters of the baseline aircraft, such as maximum take-off mass, fuel capacity, design range, cruise thrust, range and passenger capacity. Against these key characteristics he then presented the estimated characteristics for various unconventional aircraft types with different fuel systems, such as hydrogen-fuel (liquid), nuclear powered and fuel cells. After explaining the assumptions that were made for the various aircraft systems, Mr. Snyder then compared their key characteristics with that of the baseline aircraft.

For the liquid hydrogen system two versions were considered: one with fuel only in the wings and the other with fuel in the wings and fuselage. The latter system was necessary if the operational range was to be achieved. (The version with the fuel only in the wings could only achieve a little over two thousand miles in range.) The results indicated that the hydrogen aircraft would be bigger, but lighter. Placing liquid hydrogen fuel in the fuselage was believed to represent a major engineering challenge. One important drawback was that the current method of producing hydrogen was very polluting. A

"free source" of hydrogen would have to be developed (e.g., a solar process) to achieve the environmental objectives.

The nuclear powered aircraft was felt to be a major challenge for several reasons. First weight for reactor shielding requirements was believed to be a major problem. However, the safety and acceptance difficulties were felt to be overwhelming. A combination of kerosene and nuclear (hybrid system) presented the same problems regarding acceptance and shielding plus had the added negative feature of NOx and CO_2 emissions.

The fuel cell powered system would provide zero emissions (depending on the source of hydrogen), however, using today's fuel cell technology, it would be a bigger aircraft (if it were to achieve a 6500-mile range) and it would be a heavier aircraft. Fuel cell performance was an unknown as current technology is sensitive to vibration and thermal cycling. This would be a challenge to propulsion system to engineers.

The end result of Mr. Snyder's analysis indicated that with today's technology it is difficult to out perform a hydrocarbon fueled aircraft system. While other technology may hold promise for improved environmental performance, it will take considerable research and development before they are practical alternatives.

The briefing of Mr. Snyder is on the website as "Scenarios for Aviation's Growth: Opportunities for Advanced Technology: "Zero Emissions" Aircraft".

Gap Analysis and Roadmaps: Proposed Research Objectives and Activities

Mr. Wesoky, NASA opened the discussion by defining Gap Analysis and Roadmaps in terms of the new objectives and programs that are required to achieve the three Pillar Goals. The three Pillar Goals were described in terms of the emissions and noise levels of future aircraft. The emissions goals called for a reduction of total emissions by a factor of three within 10 years. The 20-year goal called for a reduction of emissions by a factor of five for new aircraft. The goals for perceived noise levels of future aircraft called for a factor of two reduction from the subsonic aircraft of today within 10 years. The 20-year goals called for new aircraft to achieve perceived noise level reductions by a factor of four.

Mr. Wesoky noted that these are very ambitious goals that cannot be achieved by a business-as-usual approach. To reach these goals NASA is using "Roadmaps" to coordinate their research and technology planning. The Roadmap becomes a plan to reach an outcome. It contains the statement of objectives in terms meaningful to the research and development effort. It specifies the timing of the key activities if the plan was to achieve the goal. Finally, the roadmap specifies the technical content of the program including the supporting or basic research that had to be accomplished if the plan was to be successfully completed.

The technical content of the roadmaps is based on the needs identified to reach the goal within the time horizons. It is important to identify the technical areas of concentration; any revolutionary concepts and all the activities needed to effectively transfer the technology.

In summing up the Gap Analysis and the Roadmaps Mr. Wesoky reiterated the importance of revolutionary concepts in achieving the three Pillar Goals. "Business as usual will not achieve the Three Pillar Goals; we need new thinking and new ways of doing things. Evolutionary approaches, while helpful, will not get us there." He noted that it is important to do some out-of –the-box brainstorming to identify new approaches and enabling technologies.

Discussion of Meeting the Needs, Identifying the Concepts and Recommendations for Road Maps

Organization and Assignments for Breakout Sessions

The participants were divided into two major breakout groups, one for Noise and the other for Emissions. Each of these groups held a general meeting to discuss broad issues related to their particular areas of concern. Dr. Carol Russo was the Discussant for the Emissions Group and Dr. Doug Dwoyer led the Noise Group. Following this general discussion by the Emissions and Noise breakout groups, each split into smaller brainstorming and drafting groups according to the interests of the participants.

For example, Emissions divided into two groups dealing with propulsion and airframe technologies. Smaller side groups were used to address other questions that did not fit neatly into either airframe or engine, such as innovation in operations to improve efficiency. The Noise group used similar smaller subgroups, one to address the technology concepts and the other to address operations. Concepts that could reasonably be expected to be available in the near term were developed. Likewise both groups also addressed concepts that were longer term in nature. The emissions group also discussed concepts that would likely be applicable to the mid-21st century.

Toward the end of this second day, Group leaders exchanged status reports with each other and their members so that issues could be shared and all participants would understand the status of both groups. At this session it was stated that some proposed concepts involved potential trade-offs, in that, technologies proposed to reduce noise might have adverse effects on emissions or vice versa.

Following this general discussion by the emissions and noise groups, the subgroups reconvened to finalize their reports for the next day's plenary session.

Noise Report and Discussion

Dr. Dwoyer introduced the noise report and provided an overview of its discussions and results. He then asked the facilitators to present the specific findings. The noise reports are on the website under "Noise Breakout Reports". Some highlights of the noise report are provided below.

There was broad agreement that the targets for noise were to provide technologies to reduce perceived levels of aircraft noise by 10dB by 2007 and 20dB in 2017. Furthermore the group believed that it was important to improve the ability to predict the effects of noise on people. The group also agreed to focus on source noise reduction, modeling and operations.

Technology options provided a broad initial list for propulsion, airframe, air space operations and integration and modeling. For these technologies the time frame was related to the two target dates proposed in the Three Pillars Goals.

Looking ahead several activities were identified that would require attention. Systems studies would be needed to evaluate and prioritize the technology options that were proposed; these would include cost and benefit analysis and the establishment of figures of merit. The potential benefits of the technology options would then need to be assessed and related to the Gap Analysis. Finally there needs to be some assessment to understand which emissions technology options have potentially negative effects on noise and vice versa. Proposed noise solutions cannot proceed without some consideration of the effects these may have on the aircraft emissions.

Comments by Ms. Betty Ann Kane:

Ms. Kane attended the first two days of the workshop but had a conflict that prevented her from presenting her views at the closing session regarding the work of the Noise Breakout Group. She did provide the following written remarks that were presented by Dr. Krisch Ahuja:

> I am not able to be at the final sessions of the Environmental Compatibility Assessment workshop this morning, as I have to be in Washington for a previously scheduled meeting of the D.C. Retirement Board. As you have requested, I am providing some reflections on the workshop issues and process that you may share with the group. I look forward to being with you at the final workshop in California in July.
>
> 1. NOISE applauded the original announcement of the goal to reduce aircraft noise by factors of 10 dB and 20 dB by NASA Administrator Goldin last year, and we are very pleased to see the serious effort being made through the workshops to advise NASA on a research and development program to reach those goals. NOISE is pleased to see aviation noise recognized as a significant environmental problem that needs to be dealt with, and not dismissed as an "attitude" problem.
>
> 2. One of the most significant things that occurred in Cleveland was the FAA's admission that the 65 dnl level for noise mitigation was based on funding considerations, and that the 1974 EPA finding that 55 dnl was the proper level to use to protect the public health and welfare was correct and could be implemented if the gains from Stage 3 conversion are not allowed to erode.
>
> 3. The involvement of environmental advocacy groups is very important both to designing the research and development and to building support for the funding that will be needed to carry out the R & D. Every effort should be made to continue to reach out, inform, and involve this sector.
>
> 4. The big missing sector is the airline industry. They will be very important in gaining congressional support, as well as needed insight for the research and implementation. I would be willing to work with you to try to get more airline representation at the next workshop.
>
> 5. There are many parallels between the recommendations of the emissions group and the noise group. However, I was struck by an apparent lack of awareness of the noise implications, both positive and negative, of many of the emissions concepts.
>
> 6. Noise from helicopters, turbo props, and other small aircraft need to be included in the program because these are a growing source of community concern.
>
> 7. Technology makes progress solving environmental problems possible, but is only a part of the solution—regulation, enforcement, and economic and market incentives will also be needed. For example, technology made Stage 3 aircraft possible, industry made them economically feasible, but the law made the phase-out happen.
>
> 8. I share Mr. Linn's concern for the wind down of the AST program, the reduction in current AST funding because they are being forced to pick up facilities charges, and the gap that will occur as AST phases out before the new program gear up. You can't start and stop research like that.

Finally, but not least: This program will need very strong advocacy to succeed. Thought needs to be given as to how to make all the right stakeholders and decision makers aware and supportive and to get it moving as soon and as big as possible.

Emissions Report and Discussion

Dr. Russo introduced the emissions report and provided a summary and overview of the findings. Dr. Rohde was then called upon to present the technology concepts that were developed by the breakout group. The emissions reports are on the website under "Emission Breakout Reports". Some highlights of emissions report are provided below.

Specific emissions goals were proposed. Generally these goals pushed toward achieving the maximum reduction practical within the time frame of the three pillar goals. In addition, some targets for the propulsion element were proposed for NOx and CO_2 (a 25% reduction in CO_2 and a 67% reduction in NOx were proposed for 2007). For the year 2012 targets of a 50% reduction for CO2 and an 80% reduction in NOx were proposed.

In addition to the targets, the group developed a broad initial list of technologies and concepts for propulsion, airframe, air space operations, and integration and modeling. These concepts cover the short run, mid term and the long run (out to 2050).

In terms of "where we need to go" Dr. Russo noted that more work needs to be done to define specific emissions goals. Systems studies are required to affirm the maximum reduction practical, and emittants other than NOx and CO_2 need to be addressed. Cost benefit studies and figures of merit will also be required to evaluate and prioritize the technology options and to map these in terms of the technology readiness levels and from there into the Gap Analysis.

Impressions

Ms. Newberg and Mr. Sutkus were asked to give their impressions of the workshop. Ms. Newberg led off this presentation by stating that she hoped the technique of seating participants alphabetically would be eliminated at the next Workshop. Some other impressions presented were:

1) Use of NASA facilitators was very effective in bringing out ideas and NASA-related activities;
2) hotel facilities were much better than Atlanta's;
3) Workshop structure and framework was improved;
4) use of the first day to address the first Workshop's issues was a good idea;
5) brainstorming was hindered by screening comments which led to the loss of some ideas;
6) fonts were too small on the computer generated presentations, and finally,
7) the web page is not being used to its full potential. Listing associated resources and contact points and getting material/charts on the web more quickly could result in better preparation for the next Workshop.

Mr. Sutkus presented some suggestions for the third Workshop, summarized in the following comments:

1) Establish links to the atmospheric research community;
2) The Workshop should revisit the noise and emission goals to compare them to technologies, compare compatibility between noise and emissions tracks, consider feasibility/technology tradeoffs, and quantify benefit;
3) Potential factors to bringing technologies to the marketplace should be considered;
4) The Workshop should continue to address the "issues list";
5) How will the conclusions of the Workshops be used and is there a role for the participants?
6) Finally, what are NASA's lessons learned?

The Way Forward

Closing Remarks by F. X. Murray

In his closing remarks Mr. Murray reviewed the following questions that had been posed as a guide for Workshop II.

1. Have the needs been met?
2. Have new concepts been put forward?
3. Have recommendations for strawman roadmaps been developed?

Skipping the first question, he noted that the participants had done a good job of responding to the second question. A number of new concepts had been put forward by the breakout groups. These concepts covered the full range of near term and long term ideas applicable to both noise and emissions environmental impacts. Reiterating the points made by those summarizing the accomplishments of the breakout groups, he emphasized that more work needed to be done to define specific goals for both noise and emissions and that some process needed to be put in place to generate and evaluate more technology options.

Regarding strawman roadmaps, NASA now had the task of developing figures of merit and conducting a cost benefit analysis to evaluate the proposals generated by the workshop. This would facilitate examining the technology options in terms of the Gap Analysis and assessing their potential contribution toward meeting the goals.

Returning to the first question, Mr. Murray noted that the participants had the assignment of talking with their constituents about the proposals placed on the table at the workshop. Do these concepts and ideas meet the needs of their organizations and constituents? Are these types of research and development programs important to aviation and the environment? At the next workshop the participants would be asked to share those views with their fellow workshop participants.

Mr. Murray thanked the participants for their hard work and their thoughtful contributions to the success of Workshop II and turned the meeting over to Mr. Wesoky for his closing thoughts.

Mr. Wesoky provided the final statements for the Workshop, which are included as attachment A-3 to these minutes.

Adjourn Workshop

The Chairman adjourned the Workshop, thanking all for their participation.

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NOTE: Comments from Rich Kassel, NRDC

Mr. Rich Kassel of the Natural Resources Defense Council was not able to attend Workshop II because of a previous commitment. However, he did have some comments that he wished to share with the participants regarding the three questions that were posed to the second workshop. His comments are provided below.

Regarding your "three additional questions", I'd briefly suggest the following:

Question #1: Have the needs been met?

I don't think the "customer" needs have been met, mostly because I don't think it's clear who the "customer" is. Traditionally, we have felt that FAA treats the airline and aviation industries as its "customer," which may be expeditious for the agency, but with unnecessary environmental and community impacts. Some might argue that the passenger is the "customer", but I'd respond that the passenger is the customer of the airlines, but not of the government agencies that are charged with regulating, planning, and mitigating the impacts for a broader population. In sum, I'd suggest that NASA's customer is that broader, general public, i.e., that you (together with FAA, EPA, DOE and other
public agencies with responsibilities in this area) have been charged with developing strategies to meet the environmental and public health needs of the general public.

Certainly, the airlines, the passengers, the other aviation industry sectors each play a role, but I'd argue that it's only an implementation role. Here's an analogy that illustrates this point: the Clean Air Act directs EPA to set national ambient air quality standards based on what's necessary to protect public health and welfare; then states develop implementation plans to meet those standards in the most cost-effective manner, taking into account local conditions and the needs of many local interested parties. In the aviation setting, NASA's goals should be based on the public health and welfare needs (e.g., noise, VOC, NOx, PM and greenhouse gas emissions); then FAA, EPA and industry initiatives can determine the most cost-effective best way to meet those needs.

If you agree with this illustration, it is easy to see that the "customers' needs" have not been met. True, there has been some progress in quieter, cleaner and more efficient aircraft. However, growing air travel offsets much of this progress. NASA's challenge in the coming years will be to determine the environmental needs of the public; then, the agencies, the industry and the public will have to work together to insure that new technologies, operating systems and other mechanisms are in place to ensure that the public's two great needs (i.e., more mobility and more environmental protection) are met in the most cost-effective manner.

Questions two and three: Have new concepts been put forward? Have recommendations for strawman roadmaps been developed?

All concepts (R & D, commercialization of new technologies; incentives for cleaner, quieter and more efficient operational systems, improved public policies) should be addressed. I wouldn't take any tool off the table at this point. But, I think NASA's role should be to help set the goals, to conduct the R & D; to create demonstration projects to test the new technologies, and to work with the various interested parties to move promising technologies to commercialization. Other policy instruments (incentives, for example) may be better left to agencies like FAA, EPA and DOE.

Thanks for the opportunity to participate in this limited fashion. Again, I'm sorry that my schedule does not permit me to spend three days with you this week. I am happy to review the SAIC staff summary, and to continue to participate in this process in the future.